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PROPELLANT FOR INTERNAL COMBUSTION-OPERATED TOOLS AND METHOD OF PRODUCING PROPELLANT IN WHICH AT LEAST ONE ISOPARAFFIN AND/OR COMBUSTIBLE SYNTHETIC OIL IS USED AS A RESIDUE-FREE LUBRICANT

BACKGROUND OF THE INVENTION

1. Field of Invention

The present invention relates to a propellant for internal combustion-operated tools, especially for setting equipment for fastening elements based on combustible gases, containing a lubricant, as well as to a method of producing a propellant in which at least one isoparaffin and/or a combustible, synthetic oil, based on esters or poly-α-olefins, is used as a lubricant and which is combustible without leaving a residue.

2. Description of the Prior Art

Internal combustion-operated tools of the type under discussion, namely setting equipment for fastening elements, are known from the DE 40 32 202 A1. With the help of these tools, fastening elements, such as nails, bolts and the like, can be driven directly, under the action of the combustion energy of a fuel, normally a powder charge or a propellant, into materials such as wood, steel, concrete and the like, to which the corresponding component is to be fastened.

Such internal combustion-operated tools usually have a combustion space, which optionally may be divided into several chambers, and a piston, which can move in a piston guide, is acted upon by the

expanding combustion gases generated in the combustion space and transfers its energy to the fastening element. Due to the ignition of a powder propellant charge or of a mixture of air and propellant present within the combustion chamber, the piston is moved away from the combustion chamber, strikes the fastening element and drives the latter into the substrate material. In this connection, the energy, obtained by the combustion of the propellant, depends to a very large extent on the rate of combustion, which, in turn, depends on the ratio of air to propellant.

The US patent 5,842,623 discloses an internal combustion-operated tool of this type, which is operated with a mixture of methylacetylene and propadiene or a mixture of propane, butane, propylene or ethane as propellant.

For the conventional, internal combustion-operated tools of this type, a mixture of, for example, methylacetylene and propadiene or a mixture of propane, butane, propene or ethane is used as fuel. For conventional, commercial internal combustion-operated tools of this type, especially mixtures of methylacetylene, propadiene, propene and/or butane is used, which is also known under the name of MAPP. Such gas mixtures are obtained as a by-product of coking bituminous coal and provide a

relatively high combustion rate, which is important for a high effectiveness of the tools.

These propellants usually are stored in the liquid phase in propellant containers. The exchangeable propellant containers are equipped with a metering head, which is fastened by means of a snap-on connection to the container. The system of propellant container and metering head is then introduced into the tool. The metering head has the task of spraying a defined amount of liquid gas into the combustion chamber for the operation of the tool. For this purpose, a metering valve is used. The metering valves include several sealing elements and moving parts, which must be lubricated during the operation. For this purpose, lubricants are usually mixed in with the propellant. It is a first prerequisite for the selection of such lubricants that they are soluble in the liquefied gases and do not undergo chemical bonding.

The object of the German patent 199 50 348 C1 is such a propellant for internal combustion-operated tools of the type under discussion on the basis of a mixture containing (A) 40 to 70% by weight of dimethyl ether, dinitrogen monoxide and/or nitromethane, (B) 8 to 20% by weight of propylene, methylacetylene, propane and/or propadiene and (C) 20 to 45% by weight of isobutane and/or n-butane. Additionally, this propellant

may contain at least one lubricant, especially a lubricant based on mineral oil and/or silicone oils.

However, these lubricants have the disadvantage that they remain largely in the combustion chamber after the combustion. Moreover, these lubricants tend to bind the abrasion wear, which arises during the operation of the tools, for example, due to wear of the sealing materials of the metering valves and of other mechanical components, as well as the dust, which is introduced together with the air required for combustion, as a result of which encrustations are formed on the surfaces of the metering valves, the pipelines and/or the walls of the combustion chamber, which affect the trouble-free operation of the tools. Since a service life of 500,000 setting processes of the fastening elements is aimed for in the case of such fuel-driven tools, there must not, in principle, be any deposition during this period of lubricant or abrasion wear residues within the combustion space under the operating conditions to be expected, that is, at air temperatures of -10°C to +50°C and setting rates of the fastening elements of 10 items per day up to 1000 items per hour. However, if necessary, it is permissible to clean the equipment after 1000 setting processes. In this case, however, it should readily be possible to remove any residues present, for example, with

the help of a rag using a conventional commercial cleaning agent, such as oil of turpentine or a lacquer thinner.

A further disadvantage of these conventional lubricants is that there are great limitations with respect to the use of sealing materials, in that they are not suitable for the preferred sealing materials based on polytetrafluoroethylene and polyimides. These sealing materials generally must be lubricated dry and are not compatible with the conventional liquid lubricants.

3. Object of the Invention

It is an object of the present invention to provide a propellant for internal combustion-operated tools of the type named above, which contains a lubricant, which ensures, even under normal conditions of use of such a tool, permanent lubrication of the sealing materials, which are to be lubricated, of the metering valves and of other mechanical parts of the tool and prevents the accumulation of solid residue materials at the surfaces of the metering valves, of the pipelines and of the combustion space and, at most, leaves behind residues that can be removed easily.

4. Summary of the Invention

This objective is accomplished by the propellant of claim 1, the method for its manufacture of claim 10 and its use according to claim 11. The dependent claims relate to preferred embodiments of the object of the invention.

Surprisingly, it has turned out that the objective, addressed above, is accomplished owing to the fact that an isoparaffin and/or a synthetic oil, based on an ester or a poly-α-olefin, which burn without leaving a residue and have a boiling point ranging from 120°C to 250°C and preferably of 185°C to 200°C, are used.

The object of the present invention therefore is a propellant for internal combustion-operated tools, especially for setting equipment for fastening elements, on the basis of combustible gases, containing a lubricant, wherein an isoparaffin, and/or a synthetic oil, based on an ester or a poly-α olefin with a boiling point ranging from 120°C to 250°C and preferably from 185°C to 200°C, burning without leaving behind a residue, is contained as lubricant.

The isoparaffin, the use of which is preferred pursuant to the invention, is a branched isomer, synthesized from a linear alkane, preferably

with 9 to 16 carbon atoms and especially with 10 to 14 carbon atoms. Isoparaffin of this type are commercially obtainable, for example, from the EXXONMobile Company or from the Chevron Philips Chemical Company.

In accordance with a preferred embodiment of the invention, a mixture of branched isomers of out canes with 9 to 16 carbon atoms and preferably with 10 to 14 carbon atoms and, in particular, a mixture of not more than 50% by weight of branched C_9-C_{12} alkanes and not less than 50% by weight of branched C_{10}-C_{14} alkanes is used as isoparaffin.

A preferred isoparaffin mixture of this type has a boiling point of 185° to 200°C, a vapor pressure at 20°C of less than 1 kPa, a density at 15°C of 768 kg/m^3, a melting point of less than -50°C, an evaporation energy of 267 kJ/kg, a specific heat capacity Cp20 of 2.028 kJ/kg/°K and a specific heat capacity of the vapor of 1.70 kJ/kg/°K.

Equally well, the synthetic oils, based on esters or on poly-α-olefins, which burn without leaving a residue and have a boiling point ranging from 120° to 250°C and preferably from 185° to 200°C, especially the commercially obtainable lubricant B99/30-13 in the form of a preparation of poly-α-olefins and an additive combination with a viscosity of 6 cSt at 40°C, are suitable as lubricant for propellants for the intended use.

Detailed Description Of The Preferred Embodiments

Pursuant to a preferred embodiment of the invention, the propellant contains the defined lubricant in an amount of 0.01 to 50% by weight and especially of 0.5 to 1.5% by weight, based on the total weight of the propellant containing the lubricant.

Surprisingly, it has turned out that the lubricants, used pursuant to the invention and especially the isoparaffins preferably used, because of the narrow scatter of their molecular composition, have excellent lubricating properties for the moving parts of the internal combustion-operated tools in question, are very compatible with the sealing materials usually used, even those based on polytetrafluoroethylene and polyimides and, when used, do not leave behind undesirable deposits on the surfaces of the tool, which come into contact with the propellant or the ignited fuel gas because, as a result of their high volatility and combustibility, these lubricants, together with the propellant, burn completely without leaving a residue and do not take up wear materials and bond them to the surfaces.

Preferably, pursuant to the invention, liquefied, combustible gases or gas mixtures, such as ethane, propane, propene, propadiene, n-butane, isobutane, butene, dimethyl ether, methylacetylene, dinitrogen monoxide, nitromethane and their mixtures are used as actual propellant.

Preferred gas mixtures of this type are liquefied natural gas, mixtures of methylacetylene and propadiene and/or mixtures of dimethyl ether, propene and isobutane. Pursuant to a particularly preferred embodiment of the invention, a mixture of 20 to 80% by weight and preferably of 30 to 40% by weight and especially of 35% by weight of dimethyl ether, 1 to 15% by weight and preferably 1 to 10% by weight and especially 5% by weight of propene and 5 to 79% by weight and preferably of 25 to 69% by weight and especially of 60% by weight of isobutane is used as combustible gas mixture.

In accordance with a further preferred embodiment of the invention, the propellant comprises, for example, a propellant gas mixture of (A) 40 to 70% by weight of dimethyl ether, dinitrogen monoxide and/or nitromethane, (B) 8 to 20% by weight of propylene, methylacetylene and/or propadiene and (C) 20 to 45% by weight of isobutane and/or n-butane.

Pursuant to the invention, the claimed propellant is produced by transferring the defined lubricant to the pressure thank for holding the propellant, introducing the gas mixture in liquefied or compressed form into the pressure tank and ensuring a homogeneous mixing of the components by recycling the gas or by rotating or shaking the pressure tank.

A further object of the invention relates to a method of at least a method of producing a propellant in which at least one isoparaffin and/or combustible, synthetic oil based on esters or poly-α-olefins with a boiling point ranging from 120° up to 250°C and preferably from 185° to 200°C is used as a residue-free combustible lubricant in the propellant based on combustible gases of the type indicated above for internal combustion-operated tools, especially for setting equipment for fastening elements.

Preferably, a branched isomer of an alkane with 9 to 16 carbon atoms, and preferably with 10 to 14 carbon atoms and especially a mixture of such branched isomers of alkanes with 9 to 16 carbon atoms and preferably 10 to 14 carbon atoms is used as lubricant.

In accordance with a particularly preferred embodiment, a mixture of not more than 50% by weight of branched C_9-C_{12} alkanes and not less than 50% by weight of branched C_{10}-C_{14} alkanes is used as lubricant.